



*Reaching Grid Parity Using BP Solar Crystalline
Silicon Technology*
for
DOE Solar Energy Technologies Program Peer Review

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OUTLINE OF TALK



- **Overall Program Objectives**
- **Target Markets**
- **Program Tasks**
- **Technical Approach**
- **Team Members and their Activities**
- **Proposed TPP Collaborative Activities**

OVERALL PROGRAM OBJECTIVES



- **Accelerated development of multicrystalline silicon technology.**
- **Module designed for use in residential and commercial markets with products designed specifically for these applications.**
- **System components designed to add value to electricity produced.**

Specific Objectives



- **Module cost reductions to:**
 - 67% of today's costs by 2010
 - 50% of today's costs by 2015
- **System cost reduction to:**
 - 60% of today's costs by 2010
 - 36% of today's costs by 2015
- **Levelized cost of electricity in 2015 of**
 - 8 to 10 ¢/kWh for residential
 - 6 to 8 ¢/kWh for commercial

- **Selected residential and commercial markets because they:**
 - **Represent more than 70% of the overall US PV market.**
 - **Are the two markets that will likely meet grid parity first.**
 - **Are two market segments in which product development can lead to the added value necessary to generate PV market growth before reaching grid parity.**

Program Tasks



- **Silicon Feedstock**
- **Casting**
- **Wafering**
- **Cells and Contacts**
- **Modules**
- **Manufacturing**
- **Inverter**
- **Monitoring and BOS**
- **System Engineering and Integration**
- **Installation and Maintenance**
- **Deployment**

- **Silicon purification**
 - Process development of solar grade silicon.
 - Use of SoG Si in Casting.
- **Casting**
 - Implementation of Mono²TM technology (single crystal quality at multicrystalline cost).
 - Development of larger casting stations & crucibles.
- **Wafering**
 - Use of thinner wafers down to 150 μm in 2010 and 100 μm in 2015.
 - Thinner wire and improved slurry with recycle.
 - Automated wafer demount and clean.

- **Cell Process**

- **Optimized design and processing for ultra-thin Mono²™ to achieve cell efficiencies of 18% by 2010 and 20% by 2015.**
- **Development of advanced metallization systems and materials.**
- **Assessment of back contact cell technology.**

- **Module**

- **Products designed for integration into specific roof types.**
- **Materials cost reductions.**
- **Improved reliability and increased safety for operation at high voltages.**
- **Improved energy collection.**

- **Manufacturing**
 - Automated handling to transition from hundreds of cells per hour to hundreds of cells per minute.
 - Improved process control.
- **Inverters**
 - Develop a residential inverter that can be remotely monitored and controlled, that accepts high voltage PV input and can charge a back-up battery.
 - Improve inverter efficiency and increase lifetime.

- **Monitoring & BOS**
 - Improved system monitoring and control with low cost components.
 - Improved reliability and lower cost of connectors
 - Develop and test an arc monitoring and suppression system.
- **System Engineering and Integration**
 - Integrated solutions using a limited number of building blocks.
 - Ancillary components integrated into major systems elements.

- **Installation and Maintenance**
 - Design of products to minimize time required on site.
 - Systems and components designed for ease of accessibility for troubleshooting, maintenance and replacement.
- **Indirect costs**
 - Reduction of indirect costs through organized deployment and integrated solutions.
 - Collaborative activities to address interconnection rules and codes.
- **To achieve parity with the grid and grow to Gigawatt levels of production will require involvement of the entire product chain.**

- **Dow Corning Corporation**
 - Silicon feedstock – Development of SoG Si
 - Conductive powders – Replace Ag in Metallization
 - Passivating dielectrics – Reduction in surface recombination velocities
 - Adhesives for frames and junction boxes
 - Pottants for junction boxes
 - Encapsulants for improved reliability and longer life
- **Ceradyne-thermo Materials**
 - Reduced impurities in ceramic crucibles used for casting
 - Larger size crucibles for larger casting stations

Team Members



- **Bekaert Corporation**
 - Development of reduced diameter wire for wafering
- **Ferro Corporation**
 - Development of Al-B paste for BSF on ultra-thin cells.
 - Development of front pastes with reduced Ag
 - Evaluate materials for non-contact printing
- **Palo Alto Research Center (PARC)**
 - Develop new approaches to printing metallization.
- **Specialized Technology Resources, Inc. (STR)**
 - Qualify and commercialize faster cure encapsulant
 - Develop fire retardant encapsulant
 - Optimize back encapsulant to reduce cost.

Team Members



- **AFG Industries, Inc.**
 - Qualify and commercialize AR Coated Glass
 - Engineer automated equipment to reduce cost and increase throughput.
- **Recticel N.A. Inc.**
 - Assist BP Solar in development of plastic frames and support structures for integrated PV products.
- **Komax Systems York**
 - Screen printer optimization for ultra-thin cells
 - Tabbing and stringing equipment for ultra-thin cells
 - High speed automation for ultra-thin cells.

- **ATS – Ohio, Inc.**
 - Wafer and cell handling equipment for ultra-thin cells.
 - In-line process monitoring and control.
- **Xantrex Technology Inc.**
 - Develop a residential inverter that can be remotely monitored and controlled, that accepts high voltage PV input and can charge a back-up battery.
 - Improve inverter efficiency and increase lifetime.
- **Fat Spaniel Technologies**
 - Develop a system for acquiring and storing data on PV system performance and status.
 - Develop interface that allows PV electricity to be dispatched when it has the maximum value.

- **Georgia Institute of Technology**
 - High efficiency cell development.
 - Characterize materials (Mono²TM) and BP Solar cells.
 - Device modeling to guide cell development and assess back contact structures.
- **Arizona State University**
 - Building integrated product design.
 - Next generation inverter development.
 - Module qualification testing
 - Module and system performance testing.

- **UCF/FSEC:**
 - **Module and connector reliability testing**
 - **Module performance testing**
 - **Module qualification testing.**
- **SMUD**
 - **Customer interface**
 - **Component and System performance testing**
 - **Utility prospective on value of PV electricity.**

Proposed Collaborative Activities



- **Standards and Codes**
 - IEEE
 - ASTM
 - IEC
 - UL
- **Public Education for PV**
 - Decathlon
 - Develop education package for elementary school children

Proposed Collaborative Activities



- **Development of accelerated tests for modules and systems**
- **Removal of non-technical barriers**
 - **Interconnect rules**
 - **Building permits**